

The AeroAstro logo features the word "AeroAstro" in a bold, blue, sans-serif font. A red swoosh underline is positioned beneath the "Aero" portion, and a red crosshair symbol is located to the right of the "Astro" portion.

AeroAstro

The ASTRONAUTIC TECHNOLOGY logo consists of the word "ASTRONAUTIC" in a green, serif font above the word "TECHNOLOGY" in a white, sans-serif font. A small globe icon is placed between the two words. The entire logo is enclosed within a black rectangular border.

**ASTRONAUTIC
TECHNOLOGY**

The word "SPORT" is written in a large, bold, yellow, sans-serif font with a black outline. A small "TM" trademark symbol is located at the top right of the letter "T".

SPORT™

The text "The AeroAstro / ATSB Small Payload ORbit Transfer Vehicle" is displayed in a bold, yellow, sans-serif font with a black outline, arranged in three lines. The background of the slide features a satellite in orbit over Earth, with a small satellite component visible in the lower right corner.

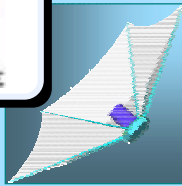
**The AeroAstro / ATSB
Small Payload ORbit Transfer
Vehicle**

The text "NASA University Satellite Programs Workshop, April 4-5, 2002, JPL" is written in a bold, yellow, sans-serif font with a black outline, arranged in two lines.

**NASA University Satellite Programs
Workshop, April 4-5, 2002, JPL**

The text "(Taken from Vehicle Overview August 2001)" is written in a bold, yellow, sans-serif font with a black outline, arranged in two lines.

**(Taken from Vehicle Overview
August 2001)**



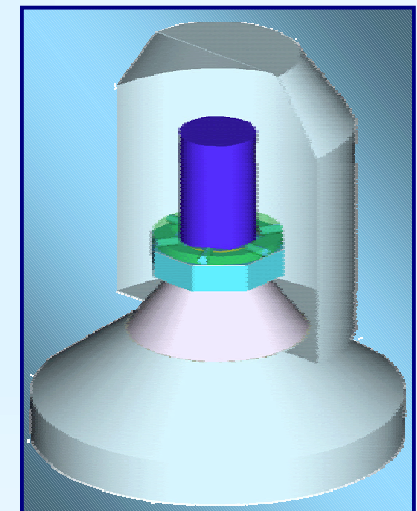
Introduction / Proposal Summary

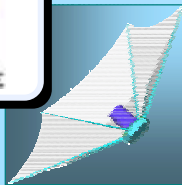
SPORT™ is a flexible, low cost, and highly reliable orbit transfer vehicle ideally suited to deploy a wide range of spacecraft into a variety of orbits:

- Three classes of SPORT vehicle support a range of payload masses

SPORT will transfer a payload spacecraft from GTO to a customer requested, circular orbit

Launch typically performed by Ariane 5





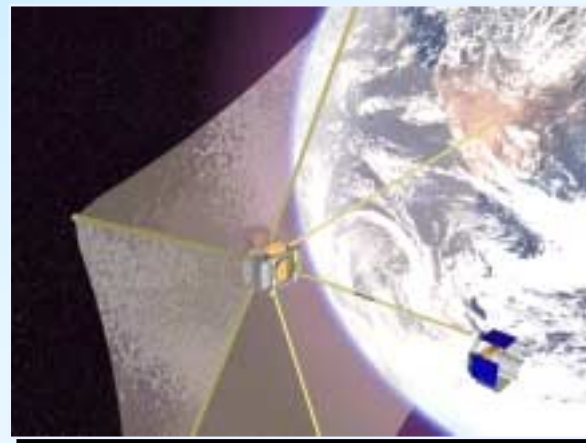
SPORT Development

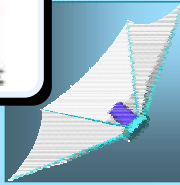
- To date, SPORT has undergone 3+ years of development at AeroAstro
- SPORT benefits from AeroAstro's spacecraft products with flight heritage: Bitsy, SunSensor, etc
- Applied for patent in early 2001; patent be issued late2001

- Future SPORTs will be utilizing flight proven designs from first launch
 - Launch
 - Space vehicle checkout
 - Payload deployment
 - Operations center

First SPORT launch
planned for late 2002

Patent on SPORT was allowed in March '01
and will be issued in September '01



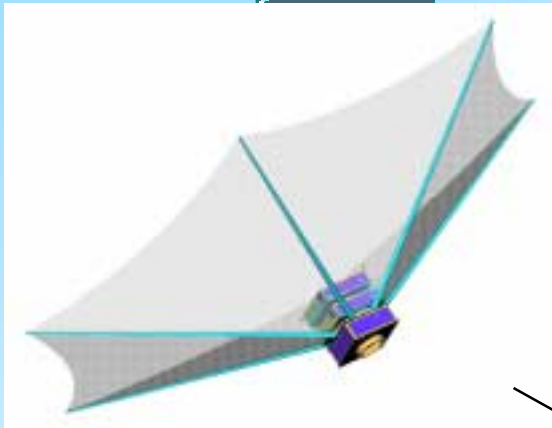


SPORT Launch Services Include...

- Orbit transfer from GTO to LEO
- Delivery of SPORT to the launch site at Kourou for integration with payload and Ariane 5
- One month of an on-site systems engineer at Kourou to support integration
- Trickle power charging services to payload during orbit transfer
- Readout of telemetry data from payload during orbit transfer, and transmission of data to SPORT ground stations for use by customer personnel
- Free-and-clear deployment of payload into its final orbit and final separation from SPORT
- Technical support of payload acquisition and initialization after deployment into its final orbit
- A full operational manual detailing all requirements and technical specifications for launch, including all interfaces between payload and SPORT
- A launch manager responsible for the payload launch and deployment, on call and available to work with customer at all times
- Access to all SPORT-Payload reviews at the SPORT team locations and full insight into program status and mission planning



SPORT Systems Overview



GTO to LEqO

- 120 kg total → 50 kg payload
- 300 kg total → 190 kg payload
- 600 kg total → 370 kg payload

Hydrazine Propulsion System

- Micro = ~275 m/s
- Mini = ~308 m/s
- Mini-XL = ~451 m/s

For orbit control and ACS

Large Deployable Aerobrake

- Micro = 30 m²
- Mini = 75 m²
- Mini-XL = 150 m²

Bitsy™ Based C&DH
With OBCA processor

Space Based 3-Axis
Attitude Determination And Control

- Star Camera
- Sun Sensors

Clampband Separation System

Downlink
2mW -1.0 W

Communications

9.6kbps
S-Band

Uplink
2 - 50 W

Power Generation

Primary thin-film array
on aerobrake (126 W avg)
Secondary GaAs on body (30 W avg)
Li-Ion batteries (30 A-hrs @14V)

Ground Based
Orbit Determination
& Mission Planning

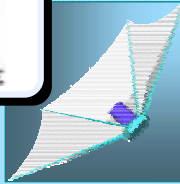




SPORT-Payload Interface

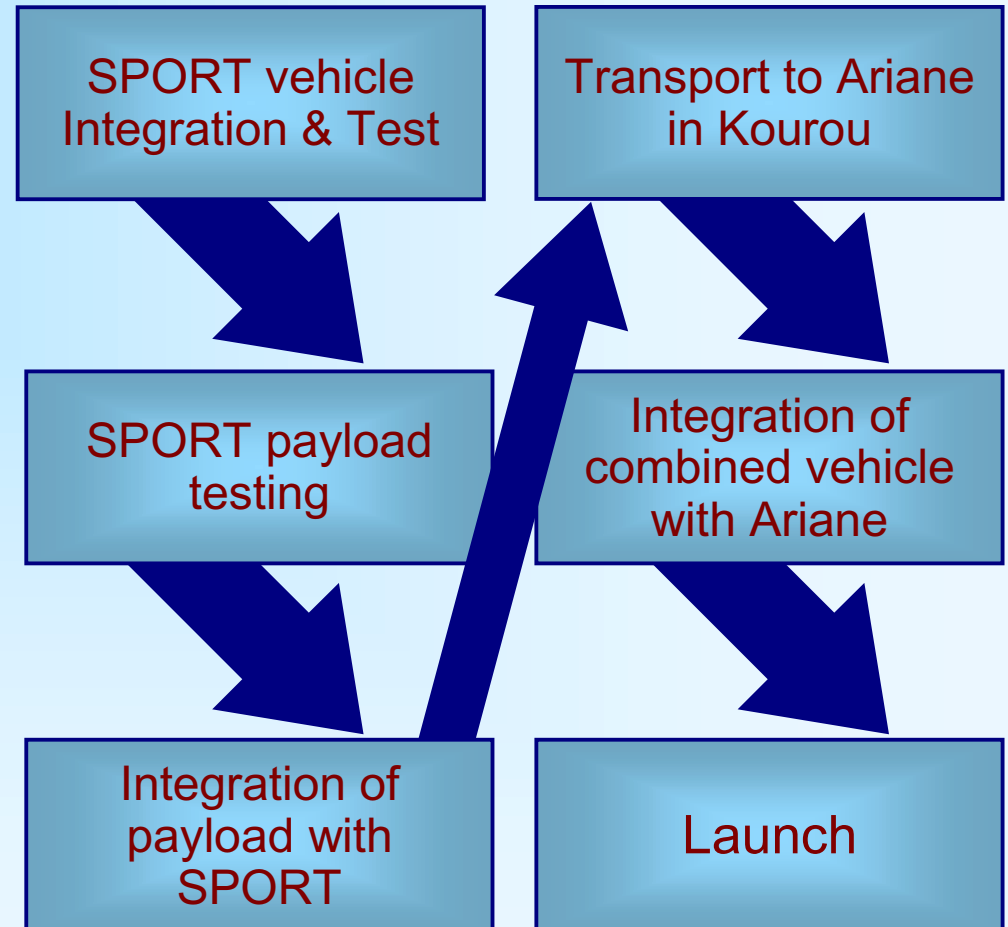
AeroAstro/ATSB Engineering Team will facilitate interface definitions and develop Interface Control Documentation. Some examples of areas covered include:

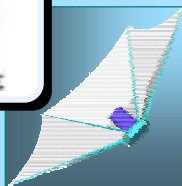
- Power
 - What is the minimum charge/voltage required by payload?
- Thermal
 - AeroAstro will assist in payload thermal assessment
- SOH Telemetry during SPORT orbit transfer
- Payload
 - Communications
 - Pre-release initialization and check-out
- Mission
 - AeroAstro will perform analysis prior mission
 - During mission, analysis will be continuously updated based on changing parameters in order to deploy payload in it's destined orbit



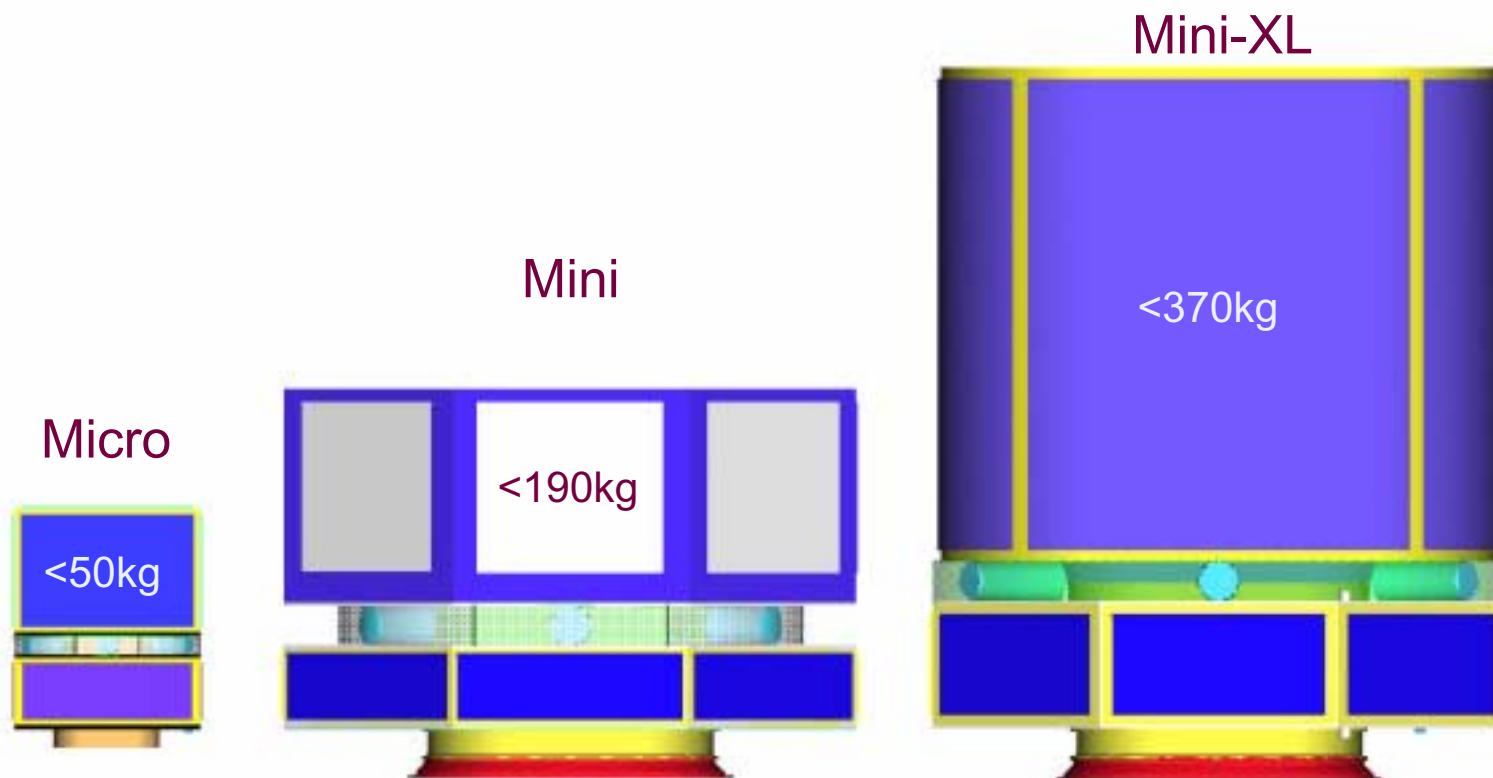
Integration Activities

- SPORT Integration & Test will begin at AeroAstro's facilities and continue in Kourou
- Several tests will be planned throughout the I&T phases

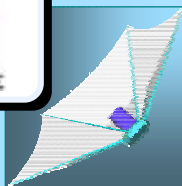




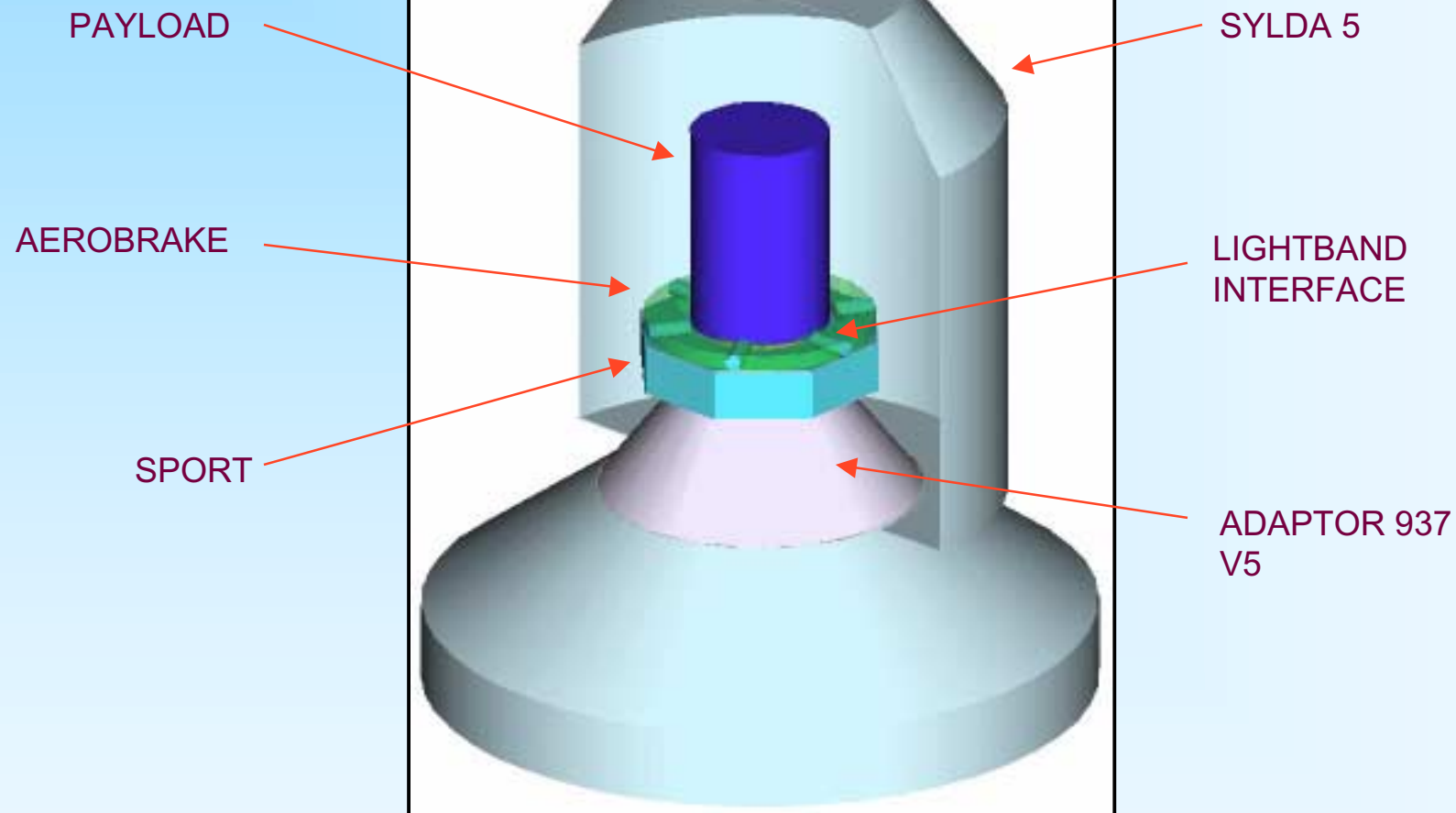
SPORT Versions

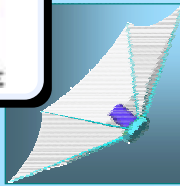


(Mass numbers are of payload mass)



SPORT on Ariane 5





SPORT Mini-XL

PAYLOAD

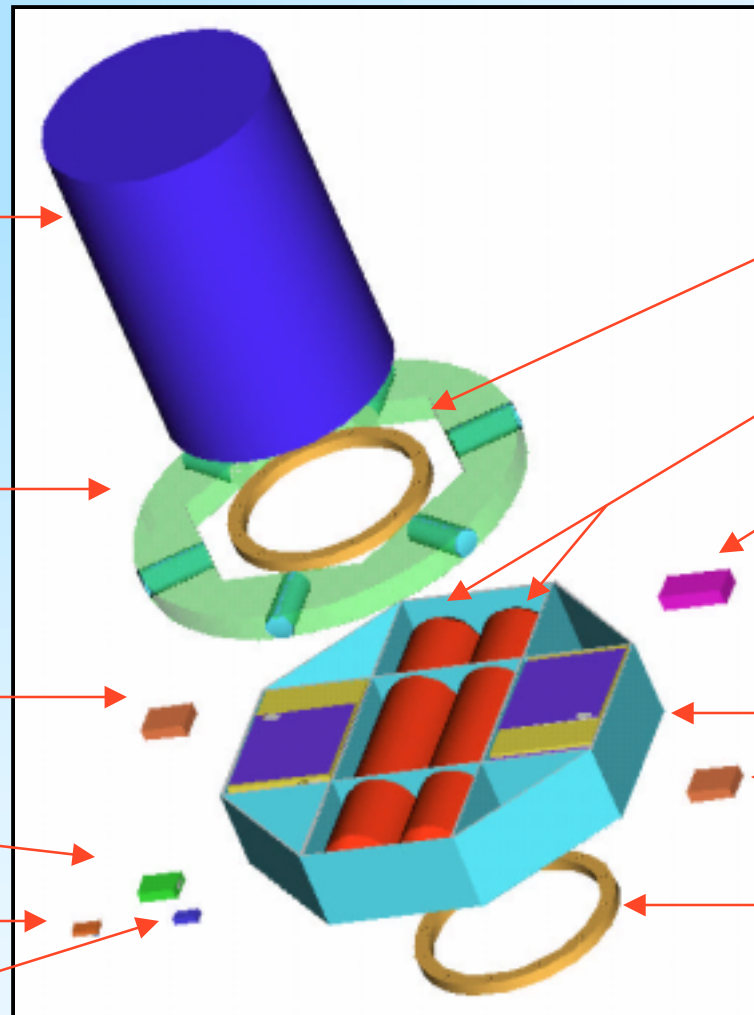
AEROBRAKE
(stowed)

BATTERIES

RADIO

STAR
TRACKER

GPS



LIGHTBAND
INTERFACE RING

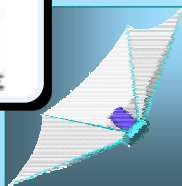
PROPELLANT
TANKS

BITSY

SPORT STRUCTURE

BATTERIES

STANDARD ARIANE
LV INTERFACE



SPORT Micro

CLAMPBAND
(INTERFACE TO PAYLOAD)

AEROBRAKE

BODY MOUNTED
SOLAR ARRAYS

S-BAND RADIO

GPS BOX

STRUCTURE
(HONEYCOMB)

MICRO PAYLOADS

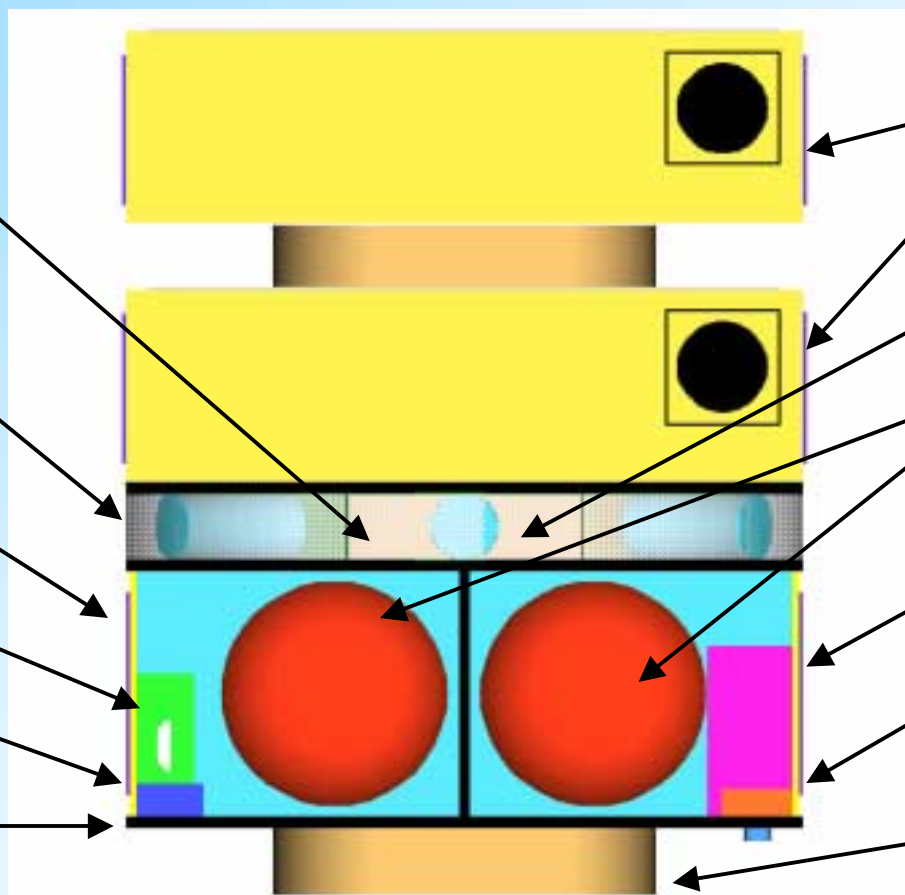
BATTERIES

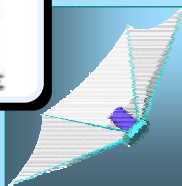
HYDRAZINE
PROPELLANT TANKS

BITSY

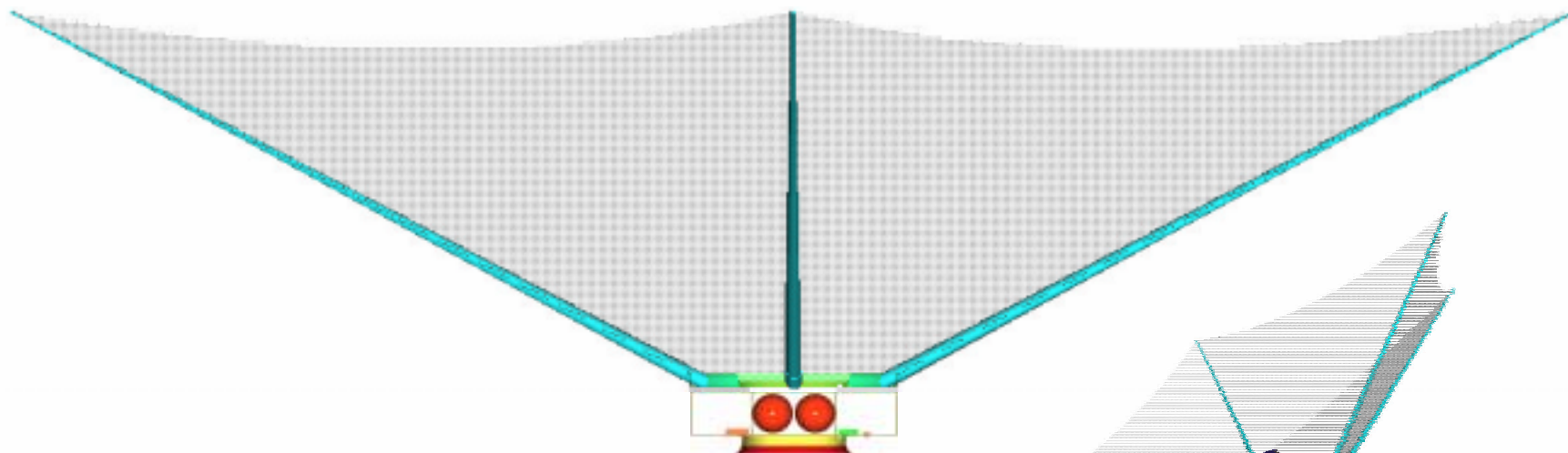
STAR CAMERA

CLAMPBAND
(SPORT INTERFACE TO
LV)

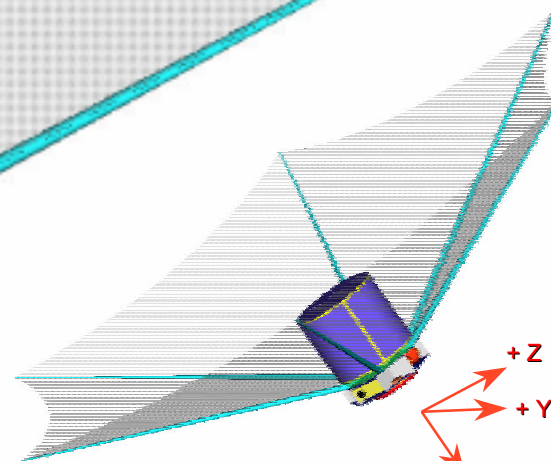




Aerobrake Deployment



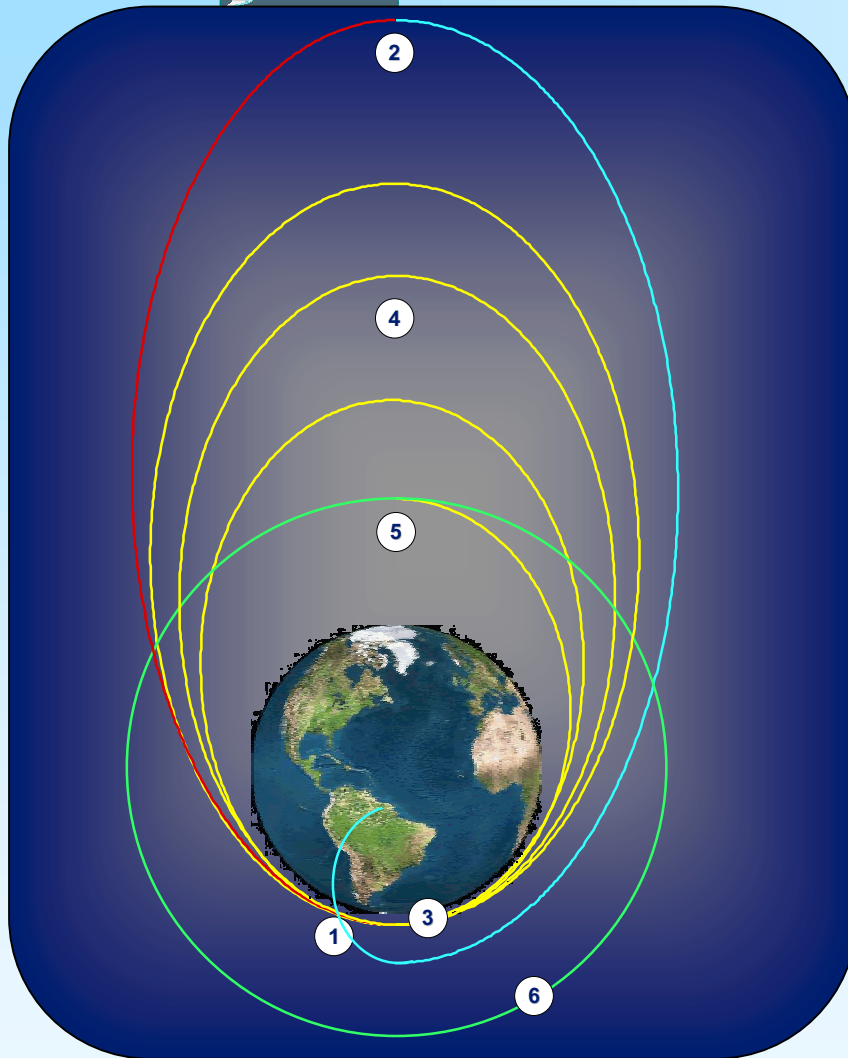
Stowed Aerobrake is deployed during initial phase of mission



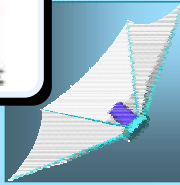
SPORT Mini-XL



Mission Description



1. Launch to GTO Aboard Ariane 5
 - Systems Checkout and Aerobrake Deployment
2. Perigee Lowering Burn
 - Lowered in Stages to Aerobraking Altitude
3. Aerobraking Drag Near Perigee
 - Atmospheric Drag Reduces Orbit Energy
4. Apogee Burns to Control Perigee
 - Counter Secular Orbit Errors
 - Control Rate of Descent
5. Perigee Raising Burn
 - End Aerobraking at Desired Apogee
 - Raise Perigee in Stages to Final Altitude
6. Final Circular Orbit
 - Trim Maneuvers As Necessary
 - Despin & Payload Release
 - Burn to Depletion to Deorbit SPORT



Mission Operations Center

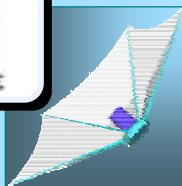
- SPORT Mission Operations Centers located at ATSB in Kuala Lumpur and at AeroAstro's facilities in Virginia, USA
- Operations Centers responsible for Mission Planning, Command & Control and Anomaly Resolution
- SPORT does not need continuous monitoring: basic "life" functions are autonomous. SPORT does not perform "special" activities autonomously and relies on ground planning and a command upload to perform (e.g., orbit adjust burns)

Planning

- Performs orbit determination based on GPS data and predicts future orbit
- Plans orbit adjust maneuvers (burns)
- Prepare commands into Command Load for SPORT
 - Command load consists of time-tagged commands for SPORT to execute

Telecommand

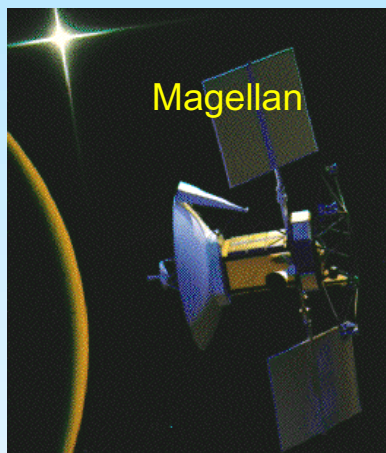
- Pre-pass activities: Arrange antenna/data connection
- Monitors SPORT, payload telemetry during contacts
- Uploads Command Load, executes other commands
- Post-Pass activities: Data archiving & trending, anomaly resolution



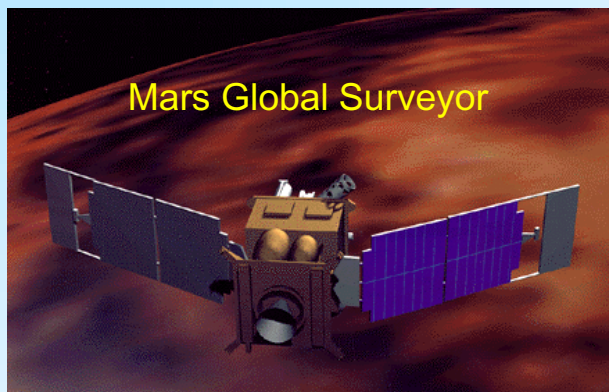
Aerobraking Heritage

SPORT aerobraking is “similar” to Magellan and Mars Global Surveyor missions flown by NASA

This similarity enables commercial leveraging of NASA experiences and technology to quickly advance the design maturity and mitigate risk



Magellan



Mars Global Surveyor



SPORT

	Magellan	Mars Global Surveyor	SPORT
Dynamic Pressure, N/m ²	0.35	0.65	0.26
Knudsen Number	3.0 - 12	0.3 - 3.0	1.3 - 14
Typical Heating, W/cm ²	0.3 - 0.4	0.08 - 0.79	0.18 - 0.26
Max Temp, C (observed / accept)	89 / 160	92 / 179	TBD / 200

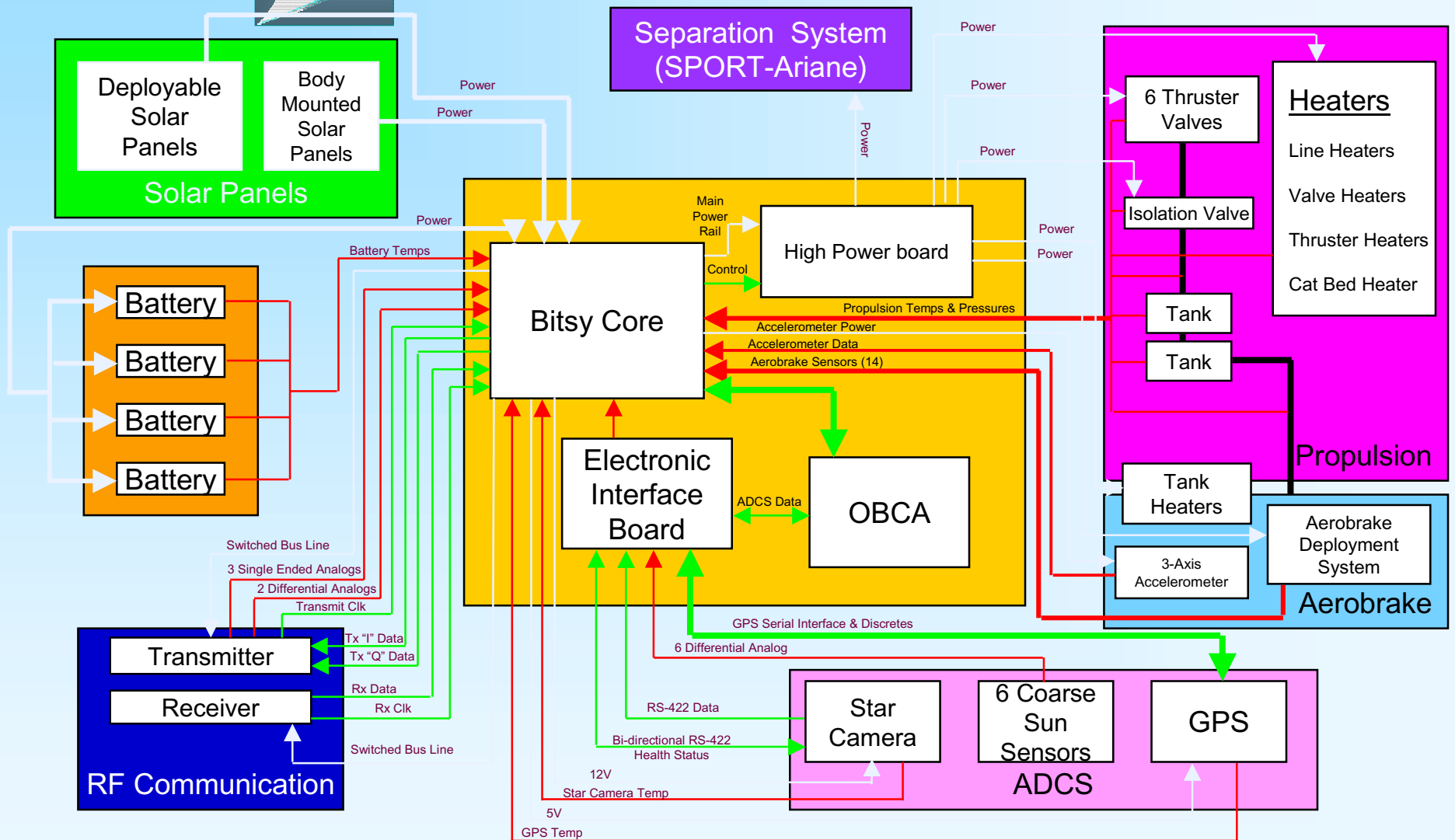


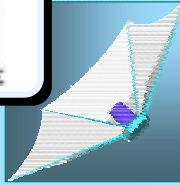
Collaboration w/NASA LaRC

- AeroAstro Is Already Partnered With
 - ATSB as a Commercial Partner/Customer
 - AFRL Through Phase II SBIRS
 - Large Deployable Structures and Modular Spacecraft
- NASA LaRC Is a Recognized Expert On Aerobraking
 - AeroAstro Seeks to Partner With LaRC Under a Space Act Agreement
 - LaRC - Transition NASA Developed Technology and Experience to a Commercial Application
 - LaRC - Provide Assistance in Addressing Key Technical and Operational Issues
 - AeroAstro – Invites LaRC Engineers to Monitor SPORT Development
 - AeroAstro - Provide NASA With Access to In-Situ Earth Aerobraking Data
- Would Like To Build A Relationship Between AeroAstro and LaRC
 - Team on other Aerobraking Opportunities
 - Reassure AeroAstro's Customers and Investors that we have the Capability and Technical Depth
 - Exchange Flight Data to Improve and Upgrade Future NASA and SPORT Missions



SPORT Vehicle Block Diagram





Attitude Determination & Control

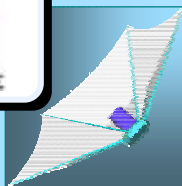
- Three Axis Stabilization System
 - SPORT coasts through most of the orbit
 - SPORT ADACS system is on for controlled orbit adjust burn maneuvers
 - SPORT also has the capability to re-orient itself before atmospheric entry
- Actuators: Thrusters
- Sensors: Sun Sensors and Star Tracker
- On-board attitude control software



AeroAstro Sun Sensor



CALTRAC Wide Angle Star Tracker

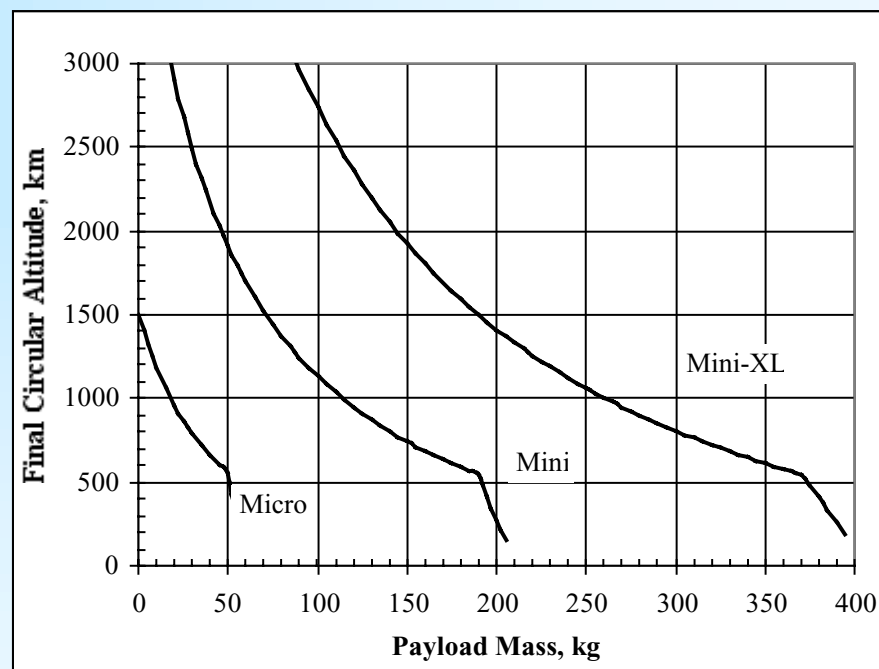


Propulsion System

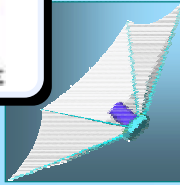
- Thruster sizes established by Attitude Control requirements
- Propulsion delta V dependant upon specific mission – payload mass and final orbit requirements

Based on 500km orbit:

- Micro: ~275 m/s
- Mini: ~308 m/s
- Mini-XL: ~451 m/s



Optimized for delivery to 500 km altitude circular orbit



SPORT Bitsy Hardware

BITSY is AeroAstro's Core Electronics Module which serves the needs of micro & nanosatellites by providing a very small, highly-integrated and reliable platform for satellite development.

- Bitsy-SX power regulation and I/O core board

- Analog monitoring points
- Digital I/O lines
- Serial communications
- Watchdog systems
- Command and Data Handling

- OBCA spacecraft processor

- 40 MIPS processing power
- 4 MB EDAC SRAM
- 1 MB EDAC EEPROM

- ADCS Interface board

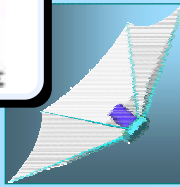
- Routes star camera, sun sensor and GPS data to OBCA

- Propulsion system power distribution board

- For distribution to high power components

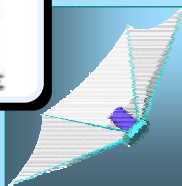


BITSY housed in SPASE assembly box. Flown late 2001.



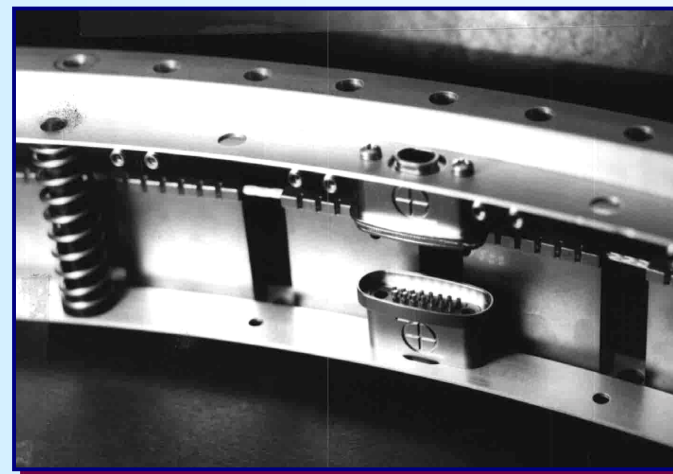
SPORT C&DH

- Main functions
 - Command detection, decoding, verification and processing
 - Communications packetization using AX.25
 - Data processing and formatting for transmission
 - Memory storage for telemetry data
 - Storage of time-tagged commands
 - Interface to ADCS sensors and actuators
- Commands
 - Execute real-time commands
 - Store and execute time-tagged commands
 - Delete time-tagged commands not yet executed
- Telemetry
 - Gather, format and download real-time telemetry upon command
 - Format and download telemetry stored in memory



Lightband Separation System

- The Lightband is a space qualified, non-pyrotechnic, low-shock initiator separation system, which induces minimal separation tip-off
- Flight heritage on 9 satellites by 2003. First flight this year. Funded privately and by the AFRL (\$1.7mil commitment)
- No pyrotechnics needed
- Height 60.3 mm, no stay-out zone
- Mass = 1.69 kg



Lightband low-friction D-style connector interface

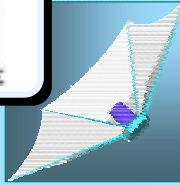
Lightband



Lightband attached to Athena rocket payload deck



Parameter	Base Lightband	Middle Lightband
Minimum margin in primary load path	9.2	19.6
Lateral first mode frequency (rigid base) [hz]	63	125
Axial first mode frequency (rigid base) [hz]	192	272



SPORT™ MISSION V-1 – THE MAIDEN FLIGHT

The maiden flight of SPORT offers a unique opportunity to participate in a history making launch and at the same time enjoy very low-cost access to space. Planned for the 3rd quarter of 2003, SPORT V-1 will launch as one of three payloads on an Ariane 5 launch vehicle – the workhorse of the commercial launch market. Once Ariane has achieved a geosynchronous transfer orbit (GTO), each spacecraft will be separated to begin their individual missions, as shown in the sequence below. Once safe separation of SPORT's main payload is assured, the CubeSat's will be ejected.

Cubesat's Wanted! Six slots for CubeSats are available on this SPORT mission. AeroAstro will offer CubeSats an exceptionally good price.

A unique flight opportunity, providing access to low-Earth orbit (LEO) at very low cost, is available on the maiden flight of the Small Payload Orbit Transfer Vehicle (SPORT™).